



WIND RIVER ENVIRONMENTAL QUALITY COMMISSION

SHOSHONE AND NORTHERN ARAPAHO TRIBES

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Dear Sandra,

Please find enclosed the draft report that we prepared for the oil and gas NPDES permits that were being renewed last year here at Wind River, in cooperation with Mike Reed and your department. Please note that this has not been finalized by our Joint Business Council yet. We gave you an electronic copy of this report earlier this year but the appendices and maps are not electronic so these were not included. Thus, we are resending you this as a hard copy that does include all of the data and appendices.

Yours truly,

Don Aragon,
Director of Wind River Environmental Quality Commission.

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Wastewater Unit

DRAFT
**Preliminary Analyses of Produced Water
Discharges
Below Oil and Gas NPDES Permits
on the Wind River Indian Reservation
by the
Wind River Environmental Quality Commission (WREQC)
November, 2005**



Precipitation Terraces below Phoenix Production Companies Rolf Lake Unit

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I. Introduction

Oil and gas is produced at foothills and basins locations throughout the Wind River Reservation. Most of these oil and gas fields have been in operation for many years and some produce significant quantities of water. Generally, the oil and gas producers treat this water to remove as much residual petroleum product as practical and then discharge the water to surface drainages under an NPDES permit issued by the US EPA. The produced water is normally discharged to ephemeral drainages which would not otherwise contain surface water except during wet weather conditions. The surface discharge of produced water from oil and gas facilities is permitted west of the 98th meridian for the benefit of livestock, wildlife, or agricultural use as long as the produced water is of good enough quality for such use and is actually put to such use during periods of discharge.

WREQC recently completed an assessment of water quality of the receiving waters downstream of several NPDES oil and gas discharge points on the Wind River Reservation. WREQC completed this assessment for the Tribal Joint Business Council, which had requested an analysis of the impacts of produced water on the Reservation. The purpose of the assessment is to document downstream water quality conditions and aquatic life below oil and gas NPDES outfalls, and to ensure that the produced water did not contain substances in amounts which could cause harm to wildlife, livestock, or the aquatic life present in the receiving waters. WREQC provided a beneficial use support summary (limited at this point to livestock and wildlife) for each stream segment below the NPDES outfalls.

The results of the assessment are presented in this report. WREQC will present this to the JBC and will also share this information with EPA and the oil and gas producers on the Reservation. WREQC hopes that this information will help the JBC make decisions about the discharge of produced water, assist EPA in writing discharge permits, and assist the oil and gas producers with management of produced water on the Reservation.

II. Assessment Design

WREQC established monitoring sites at locations downstream of the several NPDES discharge points. WREQC collected GPS coordinates at all sampling locations. The sampling sites and discharge points where WREQC collected assessment data are shown on the maps on Figures 3 through 9 in Appendix A.

Due to the limited funds and time available to complete this study, WREQC intended this to be a reconnaissance level assessment. Therefore, it was necessary to prioritize resources and focus the assessment on the areas of greatest concern. In some cases, WREQC has made recommendations in this report for the collection of additional data. WREQC understands that the NPDES permittees are also required to complete a hazard screening assessment as a condition of NPDES permit renewal. Therefore, WREQC did not conduct any sampling and analysis at the discharge points with the exception of field parameters collected at some outfalls. WREQC focused its efforts on downstream water quality. WREQC will review additional data from the permittees, and will update this draft report, as information becomes available.

Analytical Parameters and Methods

WREQC collected field parameters and grab samples of water and sediment for laboratory analysis at the selected sampling sites. Field parameters were also collected at some NPDES outfalls. WREQC analyzed the field parameters using a properly calibrated YSI multiprobe. The grab samples were analyzed for a list of toxic and/or bio-accumulative pollutants, which could be expected to be present in the produced water. Energy Laboratories in Casper, WY completed the laboratory analyses.

Macroinvertebrate samples, which are another indicator of water quality conditions, were collected and identified by Water Bear Consulting. The purpose of the macroinvertebrate samples is to document the species of aquatic life present and their types of pollution tolerances. This will allow WREQC to classify stream segments and develop site-specific criteria in the future to protect the aquatic communities that may or may not be present.

A rapid, semi-quantitative bioassessment method was employed. Macroinvertebrates were collected with a 500 micron mesh, D frame net from representative substrates in the sampling reach. The macroinvertebrates were transferred to a white bottomed pan and were picked in the field for 15 minutes total or for 7.5 min. each if two technicians were used. The samples were double labeled, stored in 75% ethanol, and transferred to Water Bear Consulting lab for identification. Lab protocols and methods are available upon request.

The lab bench sheets and macroinvertebrate reports are attached with each site analyses. Biometrics such as species diversity, were not run on these samples because of the rapid qualitative methods that were used in the collection.

Assessment Results

The chemistry data are listed on Tables 1 and 2. Table 1 contains the field and laboratory chemistry data and Table 2 contains the sediment chemistry data. Also presented on the data tables are some of the available water quality evaluation criteria. This includes the Wyoming criteria for livestock and wildlife from Chapter 2, Appendix H of the Wyoming DEQ Water Quality Rules and Regulations. The other criteria are taken from the US EPA National Recommended Water Quality Criteria and are for the protection of aquatic life. WREQC realizes that due to the nature of the produced water it is not suitable for all aquatic life. WREQC's goal is not to protect all aquatic life uses in the produced water, but to document the existing biota and to determine the causes if aquatic biota are not present.

Macroinvertebrate reports are contained in the site evaluations of Appendix A. The macroinvertebrate reports include the lab bench sheets and Access data base summary reports. The chemistry and macroinvertebrate data are also summarized on the site maps shown on Figures 1 through 7. In addition, WREQC's tentative beneficial use support determinations are provided in the site evaluations in Appendix A.

Recommendations and the decision making process.

The WREQC have developed a draft decision making process for determining recommendations to the JBC regarding produced waters/discharges. A flow chart (Figure 1.) has been developed to illustrate the decision making process. A summary of the process is as follows:

1. A toxics screen and chemical analysis of the discharge must be conducted.
2. Based upon the results of #1, above, the discharge may have to:
 - 2a. **Be reinjected** if bioaccumulative chemicals are in exceedance of the criteria and standards. This includes mercury, arsenic, selenium and radionuclides. There are many other bioaccumulative chemicals, such as some organic pesticides and herbicides but they are not likely to be present in these kinds of wells and are not required to be tested for. It is WREQC's opinion that these chemicals should not be treated or diluted because they may reappear and be concentrated in a different place downstream or off site.
 - 2b. **Be studied** for its effects on downstream stream segments/water bodies. Even if there are no exceedances WREQC recommends a downstream study such as this one, to see if the waters are really meeting their beneficial uses. The macroinvertebrates are important indicators for long term chronic problems and cumulative problems that may be missed in the one time toxic screen tests or in the chemical self-monitoring that is done at the NPDES discharge points.
 - 2c. **Receive treatment** before discharge into a stream segment or drainage if there are exceedances in the criteria and standards for chemicals that are not bioaccumulative such as sulfates, TDS, etc.
 - 3a. **One element of the downstream study** will be to determine how close the discharge water is to waters of the next higher use class and if there are any or if there will be any, violations to the Antidegradation policy. The long term 106 monitoring stations will help determine if there are changes due to the discharged water especially the hard to detect chronic and cumulative kinds of impacts.
 - 3b. The chemistry and macroinvertebrate faunas will be studied at selected downstream locations. The physical, chemical, and biological parameters change very quickly in these kinds of streams as ground waters get exposed to air and atmospheric oxygen. If the macroinvertebrate fauna is present and functioning and there are no Antidegradation issues then WREQC recommends that surface discharge be permitted. If there are no macroinvertebrates or there are only a few species present, then WREQC will try to determine why they are not there. This is important in that WREQC recognizes that there are reasons why a macroinvertebrate fauna may not exist or may be impoverished but that the water quality will still meet its higher beneficial use of wildlife and livestock drinking water. This is an exception to the hierarchical rule that is in most state and tribal water quality standards, that higher beneficial uses will meet all of the lower beneficial uses also.
 - 4a. If the study determines that there are chronic problems, such as low dissolved oxygen and high temperatures that are causing the lack of macroinvertebrates, and these problems are often associated with poor water chemistries such as high sulfides and sulfates, then WREQC recommends the waters should be treated or reinjected. This may be true even if they are meeting the chemical criteria at the NPDES point of discharge.

4b. If the study determines that the macroinvertebrates can't become established on the substrates because of the precipitation of calcium carbonate or other non-toxic precipitates or the macroinvertebrates are not there because it is a new discharge and not enough time has elapsed for colonization to take place, or if the operators have had the discharge waters turned off so that the waters have to become colonized again, then WREQC recommends that these waters be allowed to continue surface water discharges even though they are not meeting their aquatic life beneficial use support.

5. When it is determined that water quality conditions can be improved through cost effective treatment methods, or that livestock and wildlife can be prevented from accessing the discharge by fencing, then WREQC may recommend to the JBC that these options and/or the other options that are being proposed by the operators, be considered. Treatments may lower chemical constituents to safe levels but they may not be cost effective for the industry to do. Any of the possible treatments listed should be evaluated carefully by all parties involved and cooperative projects should be encouraged.

6. All treatments should not only be carefully planned but they should be monitored to make sure that they are indeed effective and working.

7. Finally it is important to note that this flow chart and the recommendations by WREQC are only for the water quality aspects of the discharges and not other soil, air, or potential land impacts. Nor does this recommendation reflect any of the economic losses or benefits to the tribes.

It should be noted, that all toxic screenings and chemical analyses data have not been received by WREQC at the time of this report. After review of all available data from the permit holders, some recommendations by WREQC may change, although this is not expected. Finally, it should be noted that these are only recommendations from WREQC and that the final decisions on these permits are made by the JBC.

IV. Discussion and Recommendations

This section discusses the findings of the assessment and makes recommendations for response(s) to the findings. This general comment and recommendation section is supported by the more detailed site specific analyses of Appendix A. Sites are analyzed by watershed and generally from an upstream to downstream order.

A. General Comments

Produced water often contains high concentrations of total dissolved solids (TDS), including sulfate and other dissolved minerals. Although high TDS does not necessarily indicate that there is anything toxic in the water, it does limit the use of the water and affects the type of aquatic life the water can support. The state of Wyoming has set effluent limitations for TDS (5,000 mg/L), sulfate (3,000 mg/L), and chloride (2,000 mg/L) that are intended to be protective for livestock and wildlife consumption. EPA has applied these recommended values in the recently issued oil and gas NPDES permits.

Other literature reviewed by WREQC, included in Appendix B, indicates that there may be health effects and reduced performance in livestock with TDS concentrations in the 2,000 to 5,000 mg/L range, and health problems should be expected above 5,000 mg/L TDS during hot weather. Sulfate levels above 1,500 mg/L may also affect health, and cases of sulfate-induced polio may be caused at sulfate concentrations above 2,500 mg/L. These literature values indicate that even more stringent limits on TDS and sulfate may be appropriate.

Therefore, WREQC and the Joint Business Council (JBC), support the EPA use of effluent limitations on TDS and sulfate in the oil and gas NPDES permits (Please see the 1992 letter written by the JBC in Appendix B). WREQC does not believe it is appropriate to issue permits without any effluent limitations, even though this was allowed on the Reservation in the past. Although WREQC does not have evidence that any livestock or wildlife have been killed or harmed by consumption of produced water, WREQC does not support the discharge of any water containing TDS or sulfate in concentrations that could be expected to cause health effects or reduced performance.

Trace metals, which are another component of TDS, may be toxic and/or bio-accumulative. With few exceptions, WREQC did not find trace metals at concentrations of concern. However, there are a few exceptions and these are described in detail in the specific comments for each site.

At many of the NPDES sites the produced water contains high concentrations of hydrogen sulfide (H₂S) and sulfide. Hydrogen sulfide and sulfide may be a significant hazard to livestock, wildlife, and humans. Alarms on H₂S monitors prevented WREQC staff from conducting sampling and analysis at several outfalls including Circle Ridge, Maverick Springs, Chatterton, Steamboat Butte, and Winkleman Dome. H₂S gas is deadly and can kill humans and animals alike without warning. Although there are warning signs, these outfalls are all on Tribal land that is open to Tribal members for hunting and other uses without restriction.

Ground water that naturally comes to the surface in the form of springs has unique physical and chemical characteristics. There is also a unique and characteristic biology associated with springs. Ground water often has little or no oxygen, is high in dissolved substances (TDS), especially if it is warm or hot, and has a steady discharge rate and steady temperatures (Hynes 1970). The substrates can be dominated by anaerobic reducing conditions and the black ooze called sapropel often forms and may be covered by precipitates. (Rutner, F. 1972). Physical, chemical, and biological changes begin to occur after the water reaches the

surface and these changes create readily identifiable zones below springs. The length of each zone will depend on many factors such as discharge, turbulence, and the chemical constituents which, in turn, are a reflection of the geologic formation or formations through which sub surface waters flow. If the water is hot or warm, it will begin to cool and many of the dissolved substances will precipitate out. Oxygen from the atmosphere will become entrained and macrophytic plants may also add to the oxygen levels through photosynthesis.

Figure 1: Water Quality Decision Flow Chart for WREQC Recommendations for Discharges

